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Block Scheduling Effects on a State Mandated Test of Basic Skills

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Abstract

This study examined the effects of a tri-schedule on the academic achievement of students in a high school. The tri-schedule consists of traditional, 4x4 block, and hybrid schedules running at the same time in the same high school. Effectiveness of the schedules was determined from the state mandated test of basic skills in reading, language, and mathematics. Students who were in a particular schedule their freshman year were tested at the beginning of their sophomore year. A statistical ANCOVA test was performed using the schedule types as independent variables and cognitive skill index and GPA as covariates. For reading and language, there was no statistically significant difference in test results. There was a statistical difference mathematics-computation. Block mathematics is an ideal format for obtaining more credits in mathematics, but the block format does little for mathematics achievement and conceptual understanding. The results have content specific implications for schools, administrations, and school boards who are considering

block scheduling adoption.

The past decade has provided schools with many opportunities to reform education at a local level. One reform movement that has gained in popularity in the past few years is block scheduling. More than fifty percent of secondary schools in the United States have opted to change their schools' schedule to one that involves longer classes (Canady & Rettig, 1995). Proponents of school reform often view block scheduling as a way to extend the traditional periods of uninterrupted class time and improve student achievement (Bevevino, Snodgrass, Adams, & Dengel, 1998; Canady & Rettig, 1995; Cobb, Abate, & Baker, 1999; Queen & Isenhour, 1998; Canady & Rettig, 1996). As the trend continues to grow throughout the United States, teachers, parents, administrators, and university professors are seeking evidence for the impact of block scheduling on student achievement. As reformers have sought better ways to increase student achievement in the high schools, the question of time used for instruction has become a major focus.

Literature Review

There have been many debates at the district and school levels about the perceived benefits of block scheduling. The results of studies have supported and denounced the implementation of block scheduling. Previous studies have reported favorable teacher attitudes and perceptions about block scheduling though the use of surveys (Pullen, Morse, & Varrella, 1998; Sessoms, 1995; Tanner, 1996). Other studies have reported on the relationship between block scheduling and student grade point averages (Buckman, King & Ryan, 1995; Edwards 1993; Holmberg, 1996; Schoenstein, 1995). These studies focused mainly on trends in grade point averages over time of implementation. Mixed results have been reported on state standardized test scores (North Carolina Department of Public Instruction, 1996) and standardized test scores (Bateson, 1990; Hess, Wronkovich & Robinson, 1998; Lockwood, 1995; Wild, 1998). Most of these studies support the longer traditional schedule over the 4 x 4 block in science for example, yet support the 4 x 4 block schedule in math and social studies. Graduation rates have also been reported to benefit from the 4 x 4 schedule (Carroll, 1995; Monroe, 1989; Sessoms, 1995). The findings of these studies have been inconsistent, sometimes reporting gains for students on block scheduling, sometimes reporting no differences, and sometimes reporting losses compared with students on traditional scheduling. Several large-sample studies, for example, have reported results in multiple subject areas. Hess, Wronkovich, and Robinson (1998) and Wronkovich, Hess, and Robinson (1997) used "retired" copies of SAT II Achievement Tests. Using the Otis-Lennon Scholastic Aptitude Test as a covariate, they conducted regression analyses on pre- and post-tests. The study concluded that there were no significant differences in student achievement between 4x4 semester and traditional schedule types in geometry and history, and a significant difference in biology and English with 4x4 semester schedule students achieving higher scores than the traditional schedule.

In a second study done by The College Board (1998), tests were examined for student achievement differences in four subject areas: Calculus, biology, US history, and English literature. An analysis of covariance using the PSAT/NMSQT as a covariate was performed on Advanced Placement examination scores. Students who were taught AP English literature under an extended traditional class time (meeting everyday for more than 60 minutes) scored significantly higher than students in a traditional schedule, and both fall and spring 4x4 schedules. Students who took the AP US history exam in both the traditional and extended traditional format outperformed those in the 4x4 block schedules. Students enrolled in an extended traditional AP biology and calculus class outperformed those students in a traditional format and the 4x4 block schedules. However, these results might be expected if more time was spent on a daily basis learning any subject. Moreover, the results reported the effects of the traditional, extended traditional, and the 4x4 schedules, but did not include other types of block scheduling (e.g., block 8, alternating block, trimester, or hybrid).

Cobb, Abate, and Baker (1999) used a post-test only, matched pairs design to evaluate standardized achievement in mathematics, reading, and writing. The researchers found that block students performed significantly less well on the mathematics standardized test. There were no differences in achievement on the standardized reading and writing test scores. The literature is consistent on the inconsistency of achievement of students within the block schedule.

Most studies have examined students after they have switched to a new schedule. Few studies have directly compared student achievement within the same school utilizing different schedules. The purpose of this paper is to add to the literature base a study which investigated student achievement on standardized tests of reading, language, and mathematics. The tests results were evaluated based upon the three schedule types within the same school. Systematic examinations of the effects of block scheduling are needed if research is to adequately inform reform movements and decisions.

Methods

Context

In the spring of 1994, discussions were held on changing the traditional day schedule at South Springfield High School (SSHS). The change to a 4x4 alternative schedule was proposed after five years of study and consideration. However, a compromise tri-schedule was implemented rather than a 4x4-block schedule. The tri-schedule included three schedules types (traditional, 4x4-block, and hybrid) running at the same time during the school day. The traditional schedule consisted of six 55-minute classes that were taught for the entire school year. The 4x4-block schedule consisted of four 87-minute classes that were taught in one semester. The hybrid schedule consisted of three traditional and two block classes taught each day.

South Springfield High School is a large, four-year school located in a medium-sized college town in the Midwest. The student population of 1800 is mostly white and includes children from the city and rural areas of the county. In the fall of 1997, SSHS began the scheduling format described earlier. Under this format, both traditional and block courses were offered in all subject areas except the performing arts and advanced placement classes. The total contact time in block courses was approximately 37 hours less than for yearlong traditional courses (Table 1). This equated to 40 fewer class meetings for block classes than traditional classes.

Table 1
Descriptive Information for Classes under Block and Traditional Formats

Schedule Descriptors	Traditional	Hybrid	4X4 Block
Class Time (mins./day)	55	55 and 87	87
Number of Days of Instruction	180	180 and 90	90
Class Time (mins./school year)	9900	9900 and 7830	7830
Classes/Day	6	5	4
Classes/Year	6	7	8
Hours/Day	6.5	6.5	6.5
Credits	12	14	16
Teacher Utilization Rate[a,b]	83%	83%[b]	75%

a. Defined as the total teaching contact hours divided by the total class time during a day.
b. Teacher utilization rate was the same for all teachers due to contract and union regulations.

Students

During their freshman year, the students were randomly assigned to a block or traditional schedule. Due to scheduling concerns with special education students and Advanced Placement classes, students were then asked to switch into different classes than originally assigned. This resulted in the formation of the hybrid schedule to accommodate the course requests. Learning from the first year's scheduling dilemma, scheduling for the second year was student driven. Students submitted requests to take certain classes in either the block or traditional format. Based upon frequency counts, certain classes were only offered in one particular format one time and in the other format multiple times. Due to the proportionately distributed classes, student choice was ultimately limited to certain class formats.

State Mandated Test of Basic Skills

The Indiana Statewide Testing for Educational Progress (ISTEP+) is a state mandated test of basic skills that all students in Grades 3, 6, 8, and 10 had to take. All 10th graders (sophomores) are required to take all three sections of the ISTEP+ test, regardless of previous year state of residence or school. The results included only those students who took all three sections of the test (N = 327). Due to absences, some students did not take certain portions of the test.

The areas tested include reading, language, and mathematics. The sub-areas of reading are comprehension and vocabulary. The sub-areas of language are mechanics and expression. The sub-areas of mathematics are concepts and applications, and computation. In addition to these sub-areas, each area has a total score and a battery score for the entire test. For the purposes of this study, only scores on the sub-areas are reported since the total areas are composed of the two individual sub-areas, and the battery is a composite of all six sub-areas. Norm Curve Equivalent (NCE) scores and the Cognitive Skills Index (CSI) were used from the result printout for analysis. The NCE and CSI scores were norm-referenced. The NCE scores (1-99) were based upon an equal-interval scale. Using NCE scores allowed us to compare scores among schedule groups. The CSI describes an individual's overall performance on the ISTEP+ aptitude test. It compares the student's cognitive ability with that of students who are the same age. The CSI is a normalized standard score with a mean of 100 and a standard deviation of 16. The test was administered over a four day period for three hours per day. Each section of the test was timed. Table 2 shows the descriptive information about the students who took the ISTEP+ test.

Table 2
Descriptive Statistics of Students Taking ISTEP+

Schedule Type	N	1997-98 Freshman GPA	CSI
Traditional	117	2.73	113.06
Block	141	3.01	113.08
Hybrid	75	3.25	116.99

Analysis

ANCOVA statistical tests were run on the SPSS computer statistical software package. Because it was impossible to obtain a randomized or matched sample in this present study, analysis of covariance (ANCOVA) was utilized for the design. The ANCOVA for each dependent variable was a one factor fixed effect (schedule type: traditional, block, hybrid) with CSI (cognitive skills index) and cumulative GPA as simultaneous multiple covariates.

Results

Reading

Both of the sub-areas for reading were analyzed and determined to be non-significant by schedule type, and thus their results are not reported. Using reading-total as an example, CSI and GPA provided significant regression effects ($F[1,331] = 160.740$, $p < .001$; $F[1,331] = 6.308$, $p < .001$) respectively. No main effect for schedule type was found for reading-total ($F[2,331] = 1.470$, $p = .231$).

Language

Both of the sub-areas for language were also analyzed and determined to be non-significant by schedule type, and thus their results are not reported. Using language-total as an example, CSI and GPA provided significant regression effects ($F[1,331] = 140.809$, $p < .001$; $F[1,331] = 51.153$, $p < .001$) respectively. No main effect for schedule type was found for language-total ($F[2,331] = .679$, $p = .508$).

Mathematics

The ANCOVA results for mathematics-computation were significant. The covariates CSI and GPA provided significant regression effects for the dependent variable ($F[1,331] = 155.369$, $p < .001$ and $F[1,331] = 53.196$, $p < .001$) respectively (Table 3). A significant main effect for schedule type (Table 3) was found ($F[2,331] = 4.380$, $p = .013$). Table 4 shows the unadjusted mean scores for the mathematics-computation section of the ISTEP+ based upon schedule type. Traditional schedule students scored significantly higher on mathematics-computation than block and hybrid students (Table 5). The traditional and block students had a mean difference of 4.175 ($p = .006$) and the traditional and hybrid students had a mean difference of 4.181 ($p = .022$).

Table 3
ANCOVA for Dependent Variable Mathematics-computation

Source	Sum of Squares	df	Mean Square	F	Sig.
CSI	22152.877	1	22152.877	155.369	.000
CUMGPA	7584.834	1	7584.834	53.196	.000
Schedule	1248.920	2	624.460	4.380	.013
Error	46624.507	327	142.583		

Table 4
Means[a] for Mathematics-computation by Schedule

Schedule	Mean	Std. Error
Traditional	69.115	1.128
Block	64.940	1.008
Hybrid	64.934	1.399

a Evaluated at covariates appeared in the model: CSI = 113.9819, CUMGPA = 2.9750.

Table 5
Pairwise Comparisons for Dependent Variable Mathematics-computation

(I) Schedule	(J) Schedule	Mean Difference (I-J)	Std. Error	Sig.
Traditional	Block	4.175	1.521	.006
Traditional	Hybrid	4.181	1.823	.022
Block	Hybrid	0.005	1.720	.997

For the dependent variable, mathematics-concepts and application, CSI and GPA provided a significant regression effect ($F[1,331] = 188.767$, $p < .001$ and $F[1,331] =$

41.867, p < .001), respectively. No main effect for schedule type was found (F[2,331] = 1.456, p = .235), thus tables are not provided due to the non-significant results. Even though three schedules existed at the high school and all students were enrolled in one of three schedules, students took mathematics in either a traditional or block format. The ANCOVA results from Table 5 would indicate that the traditional schedule is better for student achievement than the hybrid and block schedules. Mathematics was not taught in a hybrid format; only a block or traditional format. Thus a statistical ANCOVA test was performed on mathematics-computation separating the students based upon their mathematics class format. The covariates CSI and GPA, provided significant regression effects (F[1,332] = 164.238, p < .001 and F[1,332] = 43.876, p < .001) respectively (Table 6). A significant main effect for mathematics class format was not found (F[1,332] = 0.018 , p = .892).

Table 6
ANCOVA with Dependent Variable Mathematics-computation for All Sophomores

Source	Sum of Squares	df	Mean Square	F	Sig.
CSI	24069.004	1	24069.004	164.238	.000
CUMGPA	6429.975	1	6429.975	43.876	.000
Format	2.703	1	2.703	.018	.892
Error	48068.272	328	146.550		

Discussion

Reading and Language

There is no schedule that is significantly better than another for student achievement on ISTEP+ reading and language scores. After adjusting for differences in CSI and GPA, students scores on the reading and language portions of the ISTEP+ were comparable. In essence, the schedule type did not influence positively or negatively student scores. The findings of this study confirm the results found in previous studies. Cobb, Abate, and Baker (1999) and Holmberg (1996) reported that there were no differences in student achievement on reading and writing standardized test scores. In terms of the development of reading and language skills, as long as students are taking classes for the same amount of time each year, reading and language scores might be expected to remain the same. Perhaps all classes that a student might take under any schedule format, reinforce reading and language skills by incorporating some kind of reading and language component to their curriculum. Reading and language skills are most often found and needed in all types of curriculum and are thus reinforced across all classes.

Mathematics

The traditional schedule seems better for the understanding and retention of mathematical computation as determined from ISTEP+ scores for sophomores. Some studies have reported that block scheduling was desirable because it allowed for more credits and classes to be taken (Queen & Isenhour, 1998). What has not been examined is how a decrease in total time throughout the year due to a schedule change might influences mathematics learning. Does taking a mathematics class everyday with a longer total percentage of time in class benefit a student over taking more mathematics classes with less time in each math class?

Table 6 shows the ANCOVA results for mathematics-computation based upon mathematics format of all students taking the ISTEP+. The non-significant results indicate that the mathematics format taken by students does not have an impact on their standardized mathematics test scores. Thus, schedule type was not a factor in the test scores for sophomores even though parts of the curriculum were left out of the block format classes due to time constraints (see Table 1). It is also interesting to note that the students were equalized using the two covariates. Initial glance of the unadjusted means might indicate that the traditional students actually did better. This was not the result. Another issue that has been discussed as an advantage of block scheduling is that students can take more classes, including more core classes such as mathematics, under the 4x4 block schedule (Queen & Isenhour, 1998). At SSHS, proponents of block scheduling used this argument to bolster support for block scheduling. If a student could take more mathematics courses, could the student complete and understand the curriculum? In order to answer this question we examined 76 sophomores that took more than one mathematics class their freshman year. Of those students one was in the traditional schedule and one was in the block schedule. Seventy-three students who took more than one mathematics class were hybrid. These hybrid students had the opportunity to take the mathematics classes in either a block or traditional format. Twenty-two of the 73 hybrid students took their mathematics classes in a block format, and 51 took their mathematics classes in a traditional format. Table 7 shows the ANCOVA results for mathematics-computation for those hybrid students who took their freshman mathematics classes in either the traditional or block format. Those students who had mathematics for a longer daily period (block) all year scored the same on the ISTEP+ mathematics section as those students in a traditional format after adjusting for CSI and GPA. This result indicates that taking more than one mathematics class does not increase a student's mathematics achievement. Thus, the argument that block scheduling would allow more students to take more mathematics classes is true, the impact of the increased learning is not justified due to the lack of time and curriculum in the mathematics classes due to the shorter class hours in the block format.

Table 7
ANCOVA with Dependent Variable Mathematics-computation for Hybrid Sophomores

Source	Sum of Squares	df	Mean Square	F	Sig.
CSI	5560.221	1	5560.221	47.473	.000
CUMGPA	1568.259	1	1568.259	13.390	.000
Format	174.561	1	17.561	.150	.700
Error	8081.619	69	117.125		

Moreover, those hybrid students who took more than one math class their freshman year scored similarly when they took mathematics classes in the block schedule. In essence, the hybrid students who took more than one math class their freshman year not only took math daily, but were immersed in mathematics for a longer period of time every day for an entire year. Even though these students lost content in the block format, they made up for the lose with increased amount of mathematics content at higher levels. These results support the conclusion that mathematics is best learned and understood under a daily format. Also, more time spent on learning mathematics concepts in an extended period seems to reinforce those concepts. In essence, block mathematics is good for taking more mathematics classes and obtaining more graduation credits, but the block format per se does little to increase students' understanding of mathematics.

Another issue is the possible "gap in learning" resulting from a block schedule student taking mathematics his/her first semester freshman year and not taking it again until his/her sophomore year. We were unable to determine the effect of the "gap in learning" associated with the 4x4 block schedule. By looking at the mathematics-computation scores, it would indicate that the "gap in learning" was not a significant factor in mathematics achievement as many previous people have perceived (Kramer, 1996; Wronkovich, Hess, & Robinson, 1997). We can speculate that the "gap in learning" was not an issue since the difference in scores on the mathematics-computation section was not significantly different from those students in the traditional and block schedules (see Table 6).

The results found in this study confirm those found in other studies, while conflicting with some others. Learning mathematics under an extended schedule format (daily and greater than 60 minutes) was advantageous for students using an Advanced Placement achievement test (The College Board, 1998). These results also confirm findings by Cobb, Abate, and Baker (1999). Several studies have reported higher grades for students in block mathematics (e.g., Carroll, 1995; Stennett & Rachar, 1973). In essence, some mathematics results due to scheduling type reported in the literature are tenuous at best. Fewer studies have been completed and reported in the literature using standardized tests (Cobb, Abate, & Baker, 1999; Hess, Wronkovich, & Robinson, 1998; The College Board, 1998).

Conclusions

This study supports the importance of daily instruction and contact time to student achievement in mathematics as distinct from other academic skills. However, the mechanisms that determine this relationship are less clear, and educational policy makers would be unwise to conclude that one type of schedule is generally better than others independent of how different schedules influence the number and type of courses that students take across the secondary curriculum. More research is needed to address the concern of "time-of- discipline." Does a block schedule improve student achievement even when the total amount of time is decreased within discipline areas? Which academic areas are most negatively and positively effected by the switch to a particular schedule type? Should one schedule be the model for all schools? These are important questions that need to be answered by researchers in different academic areas.

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